Investigations into Particulate Matter Sampling at Texas A&M University

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Presented to USDA Air Quality Task Force, September 8, 2016, Sacramento, California

Current and Recent Research Related to PM Sampling

- Large Particle Penetration During PM10 Sampling (2013)
- Low Volume Total Suspended Particle (LVTSP) Sampler Performance (2013-2016)
- PM2.5 Sampler Performance (2014 – 2016)

Causes and Implications of Large Particle Penetration during PM_{10} Sampling

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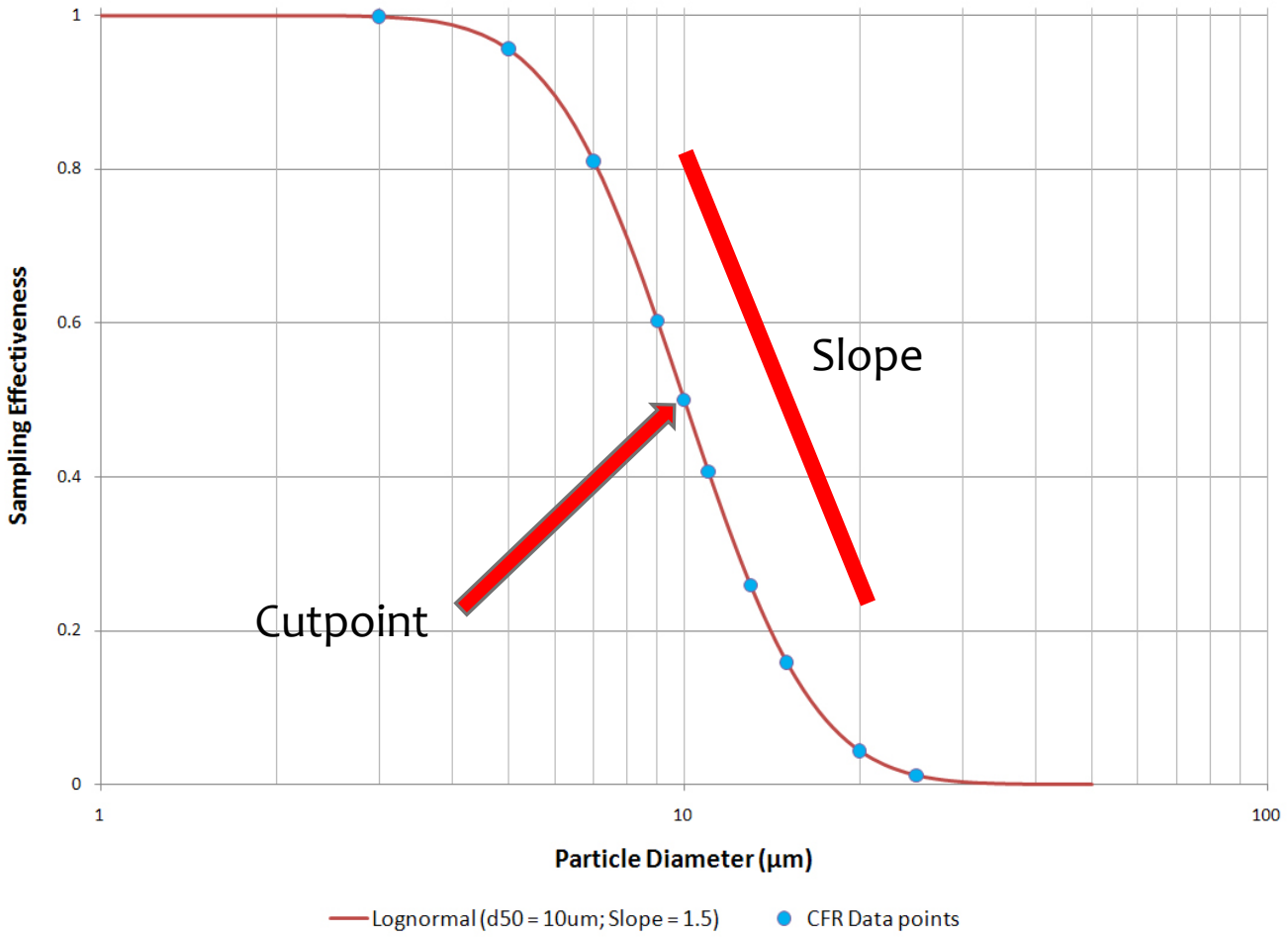
Abridged from a version originally presented to USDA Air Quality Task Force, December 2013, Beltsville, Maryland

Faulkner, W.B., R. Smith, and J. Haglund. 2014. Large particle penetration during PM10 sampling. Aerosol Science and Technology 48: 676-687.

FRM PM10 Samplers

- Performance metrics specified in 40 CFR 53 Subpart D
  - Wind tunnel testing
  - Sampler cutpoint
  - Estimation of mass collected from a standard aerosol relative to an “ideal” sampler

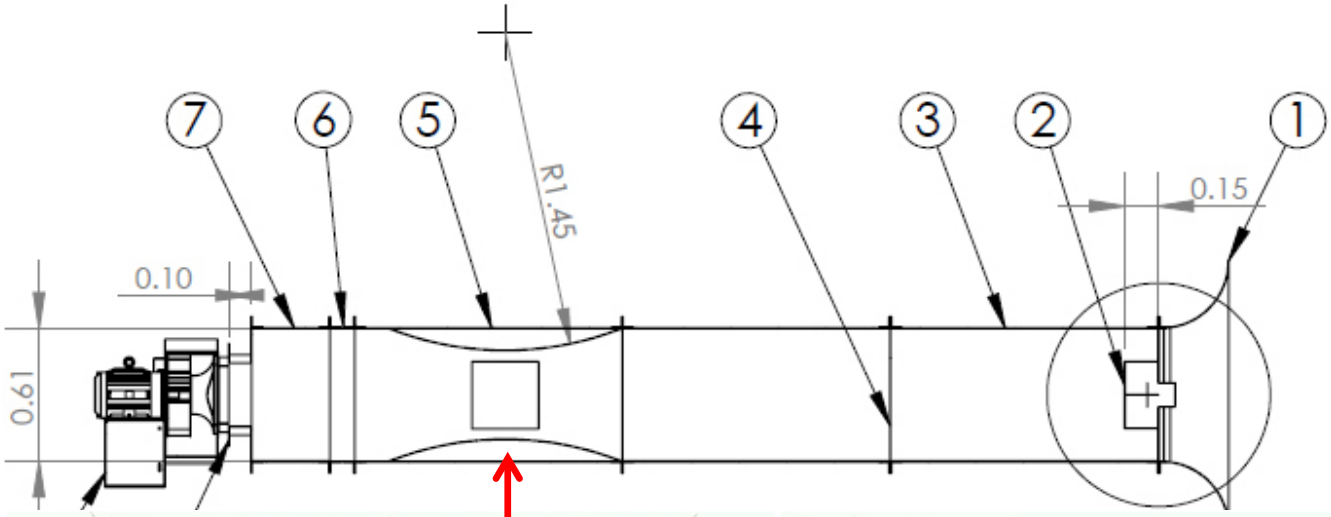
FRM PM10 Samplers

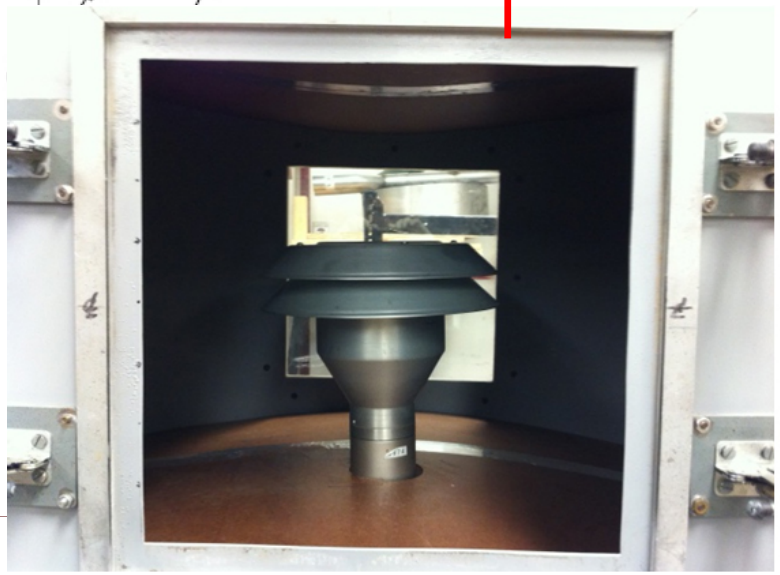


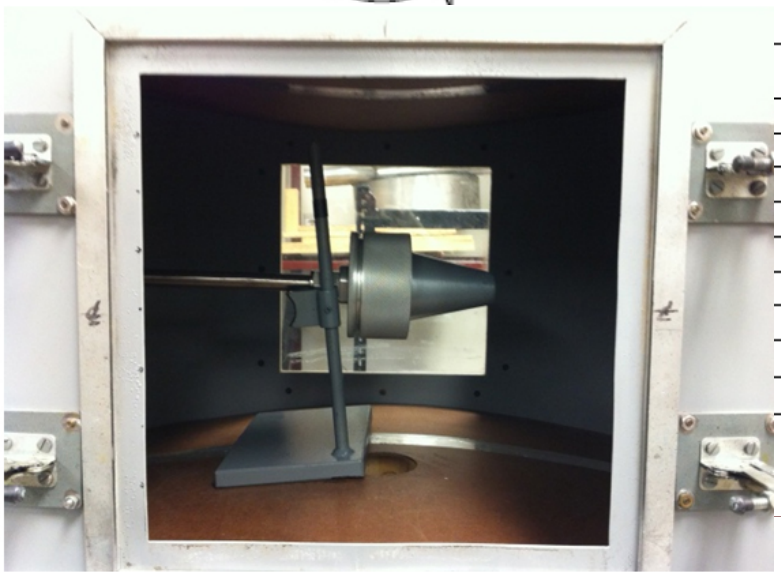
Study Objective

Characterize the performance of a FRM PM10 size-selective inlet using analysis methods designed to minimize the uncertainty in measured sampling effectiveness values for large particles.

Methods

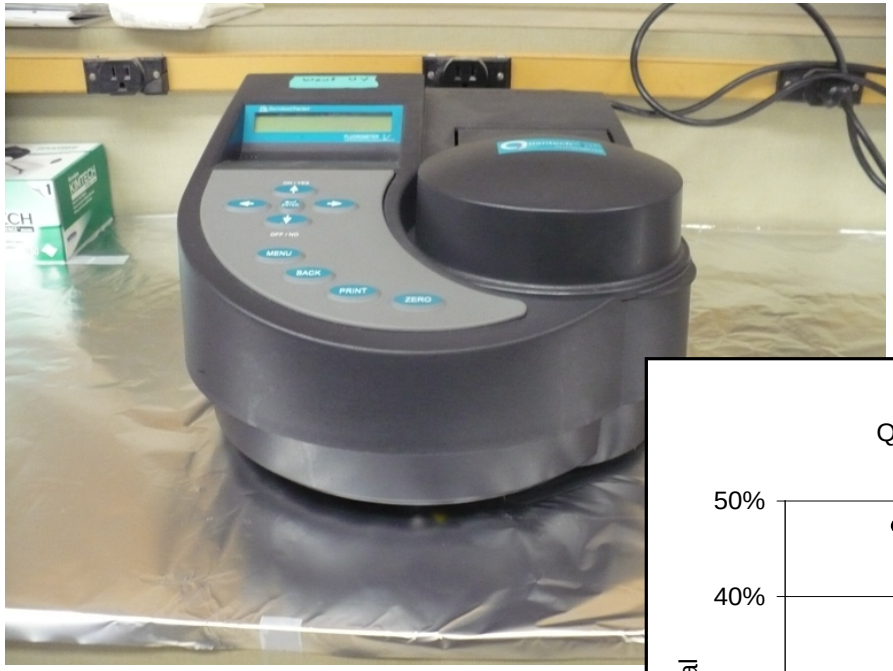




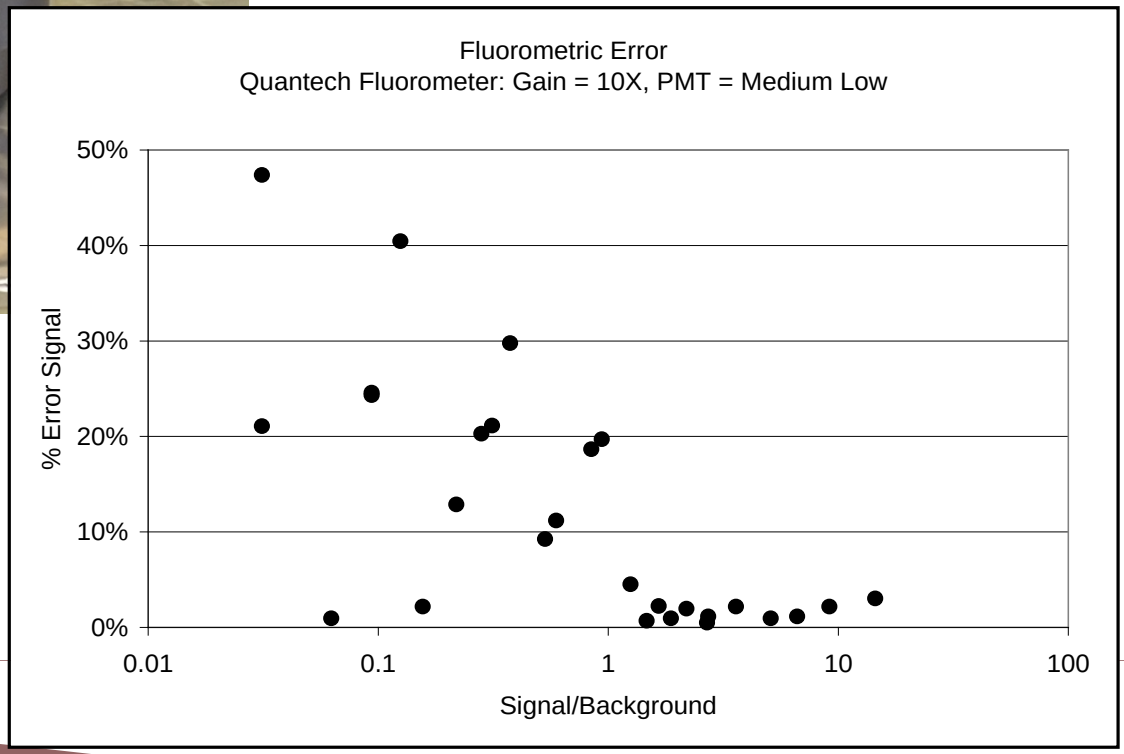


QTY.
1
1
2
1
1
1
1
1
1

Methods



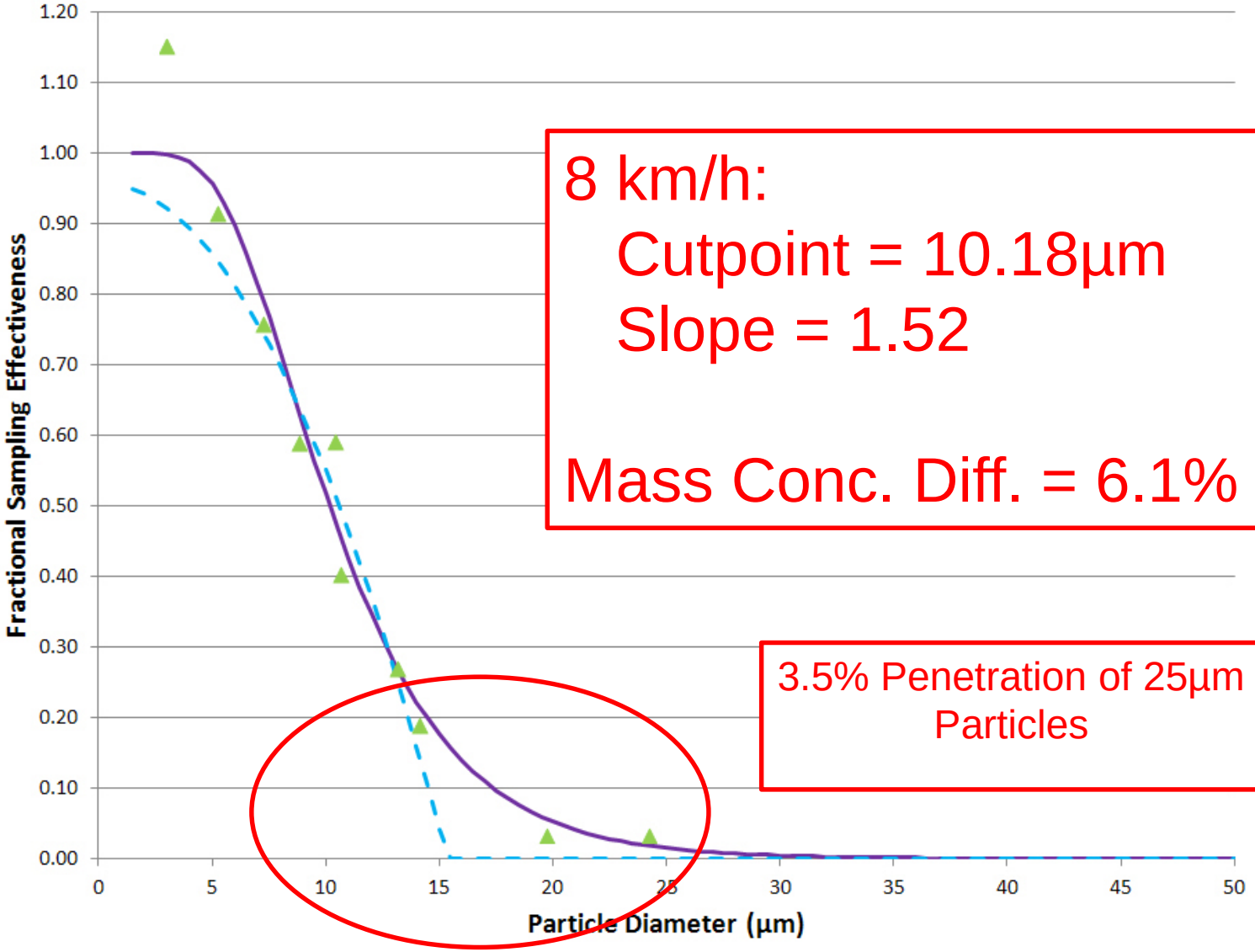
QAQC for low signal differed from previous studies



Multiplet/Satellite Correction

- Subpart D
  - Microscopically count doublets and triplets
  - Ignores satellites
  - Limited sample size
- TAMU Method
  - Use APS to quantify distribution
  - Corrects for particle stretching

Results



8 km/h:
Cutpoint = 10.18µm
Slope = 1.52

Mass Conc. Diff. = 6.1%

3.5% Penetration of 25µm Particles

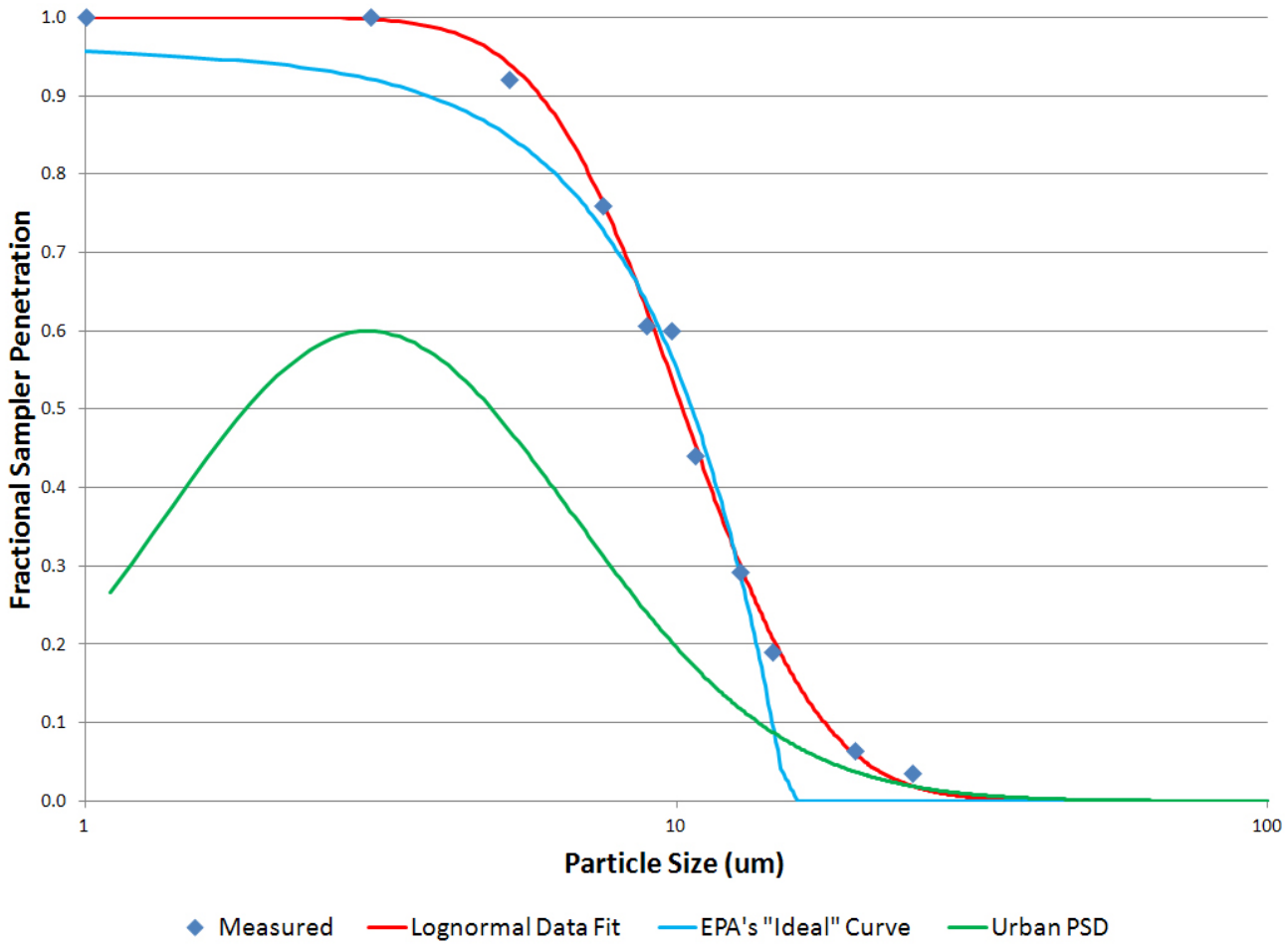
Results

Large Particle Penetration

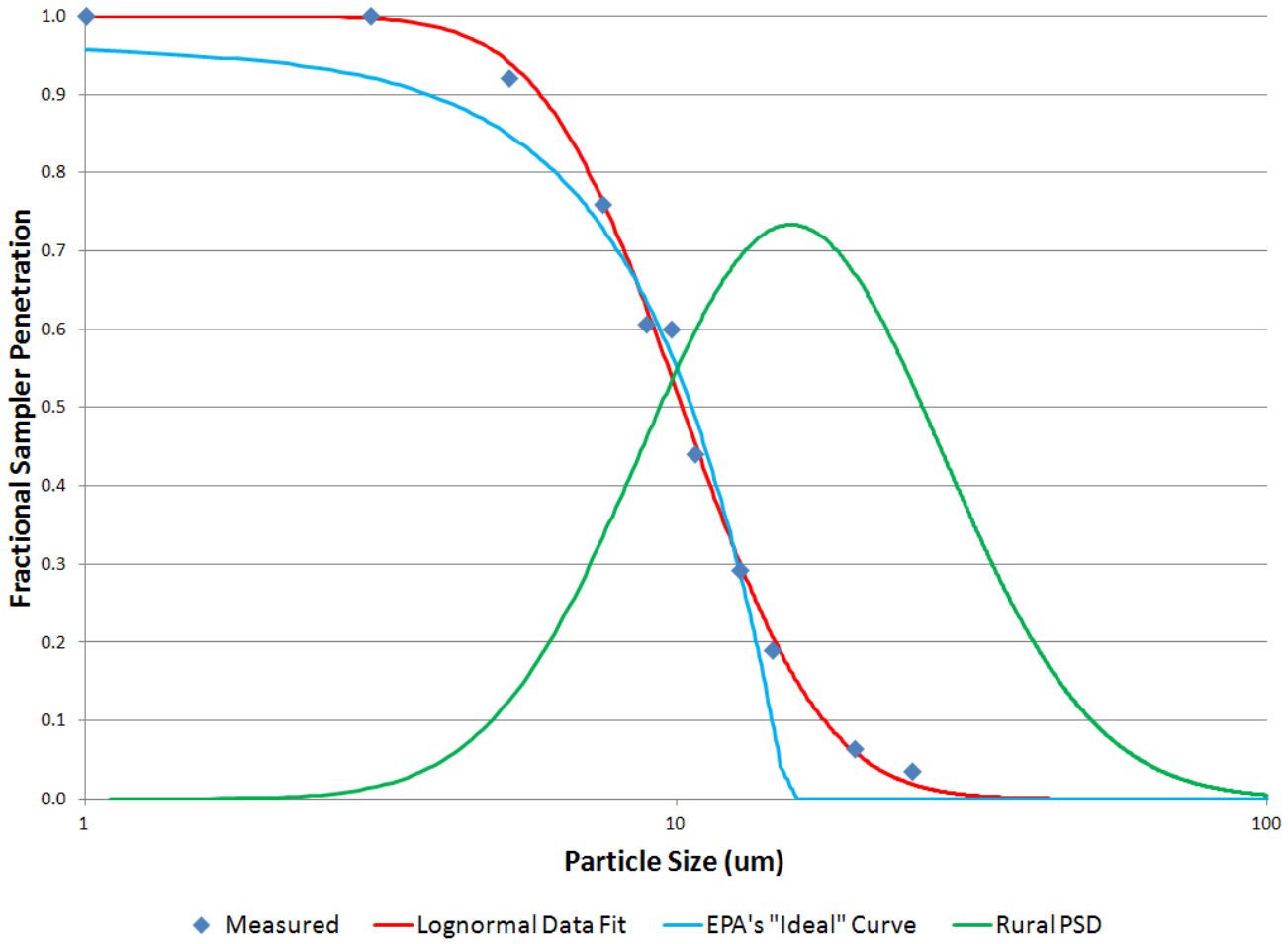
Wind Speed	20µm Particle	25µm Particle
2 kph	0.5±0.3%	0.01±0.01%*
8 kph	3.4±2.8%	3.5±0.8%
24 kph	5.4±2.5%	3.8±1.4%

*Not statistically different than "zero"

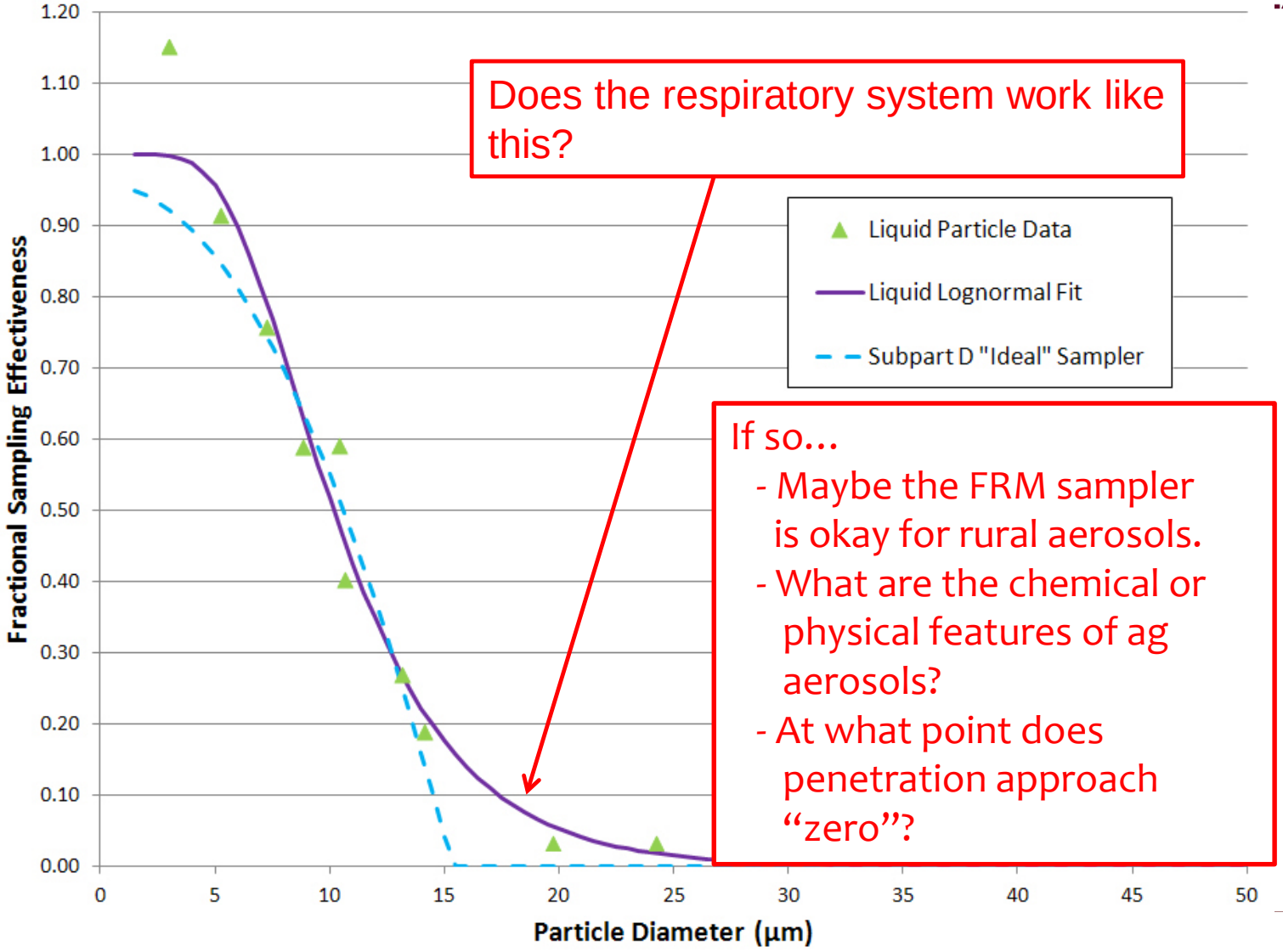
Implications



Implications



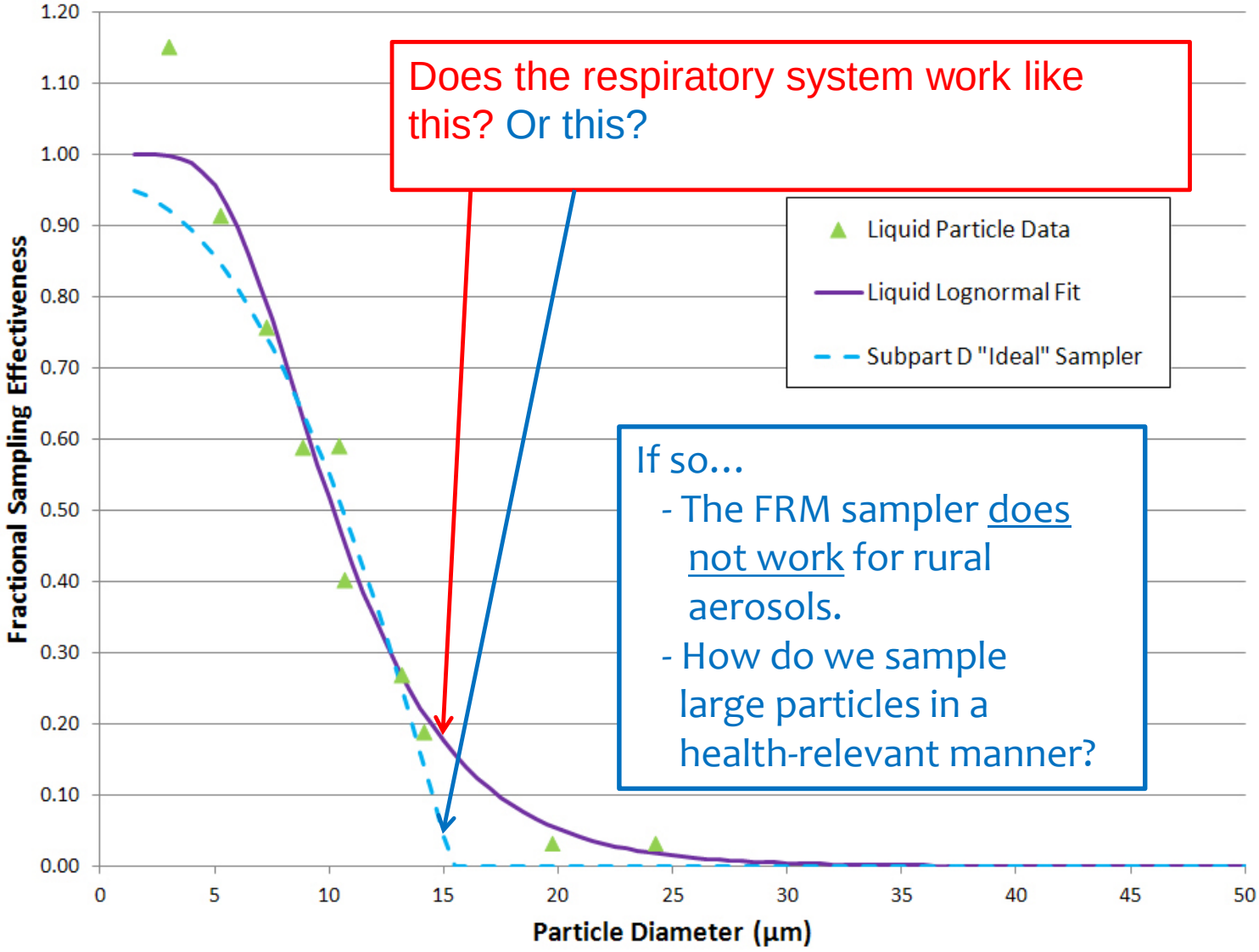
Implications/Questions



If so…

- Maybe the FRM sampler is okay for rural aerosols.
- What are the chemical or physical features of ag aerosols?
- At what point does penetration approach "zero"?

Implications/Questions



If so…

- The FRM sampler does not work for rural aerosols.
- How do we sample large particles in a health-relevant manner?

Thanks…

- Cotton Foundation
- Texas AgriLife Air Quality Initiative
- Bob Vanderpool / EPA
- RTI for technical discussions
  - Seung-Hyun Cho
  - Christie Sayes
  - Quentin Malloy

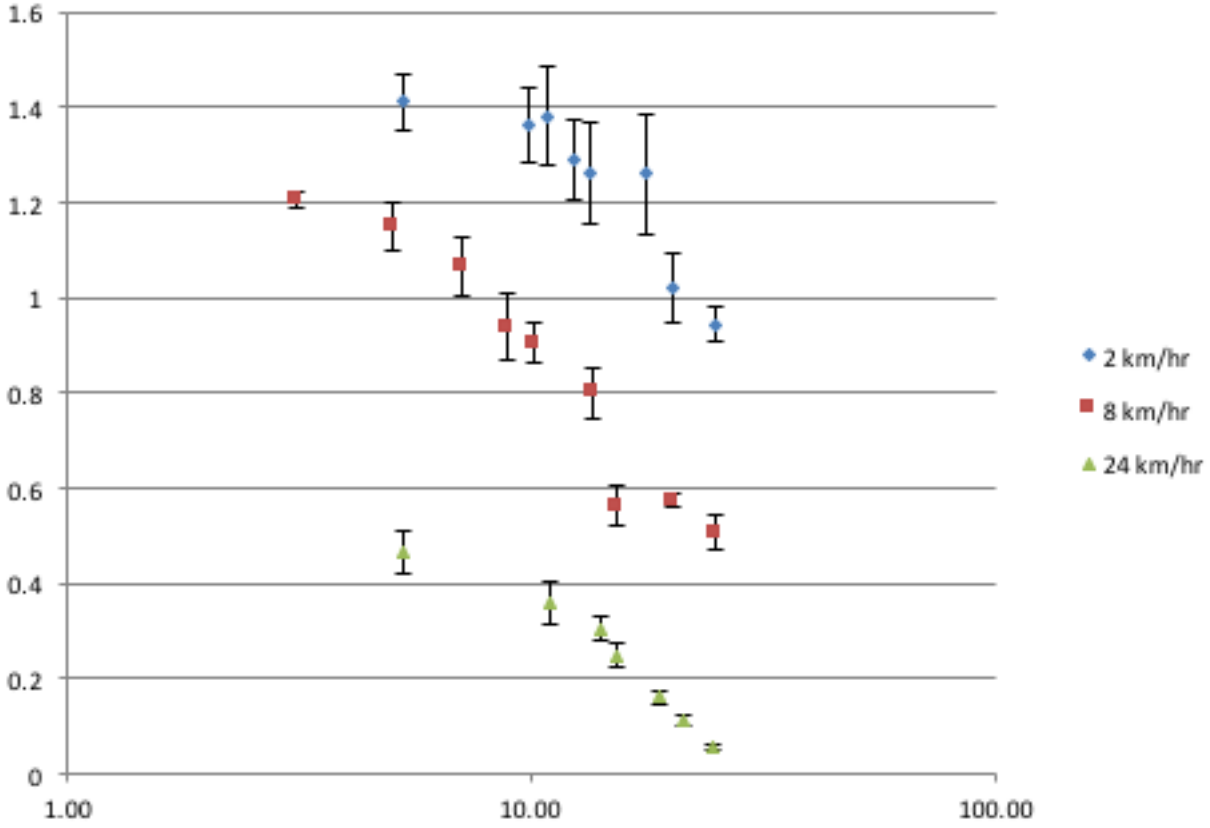
Low Volume Total Suspended Particle Sampler Performance

(2013-2016)

Raleigh Smith and William Brock Faulkner

TEXAS A&M AGRILIFE RESEARCH

Sampling effectiveness results from the wind tunnel testing of the LVTSP



Comments

- Data collected following Subpart D methodology

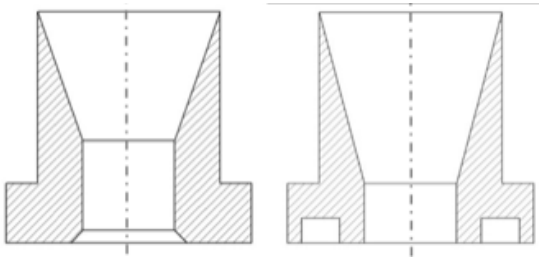
PM2.5 Sampler Performance

(2014 – 2016)

Huan Li, Brock Faulkner, John Haglund,
Maria King, & Ronald E. Lacey

TEXAS A&M AGRILIFE RESEARCH

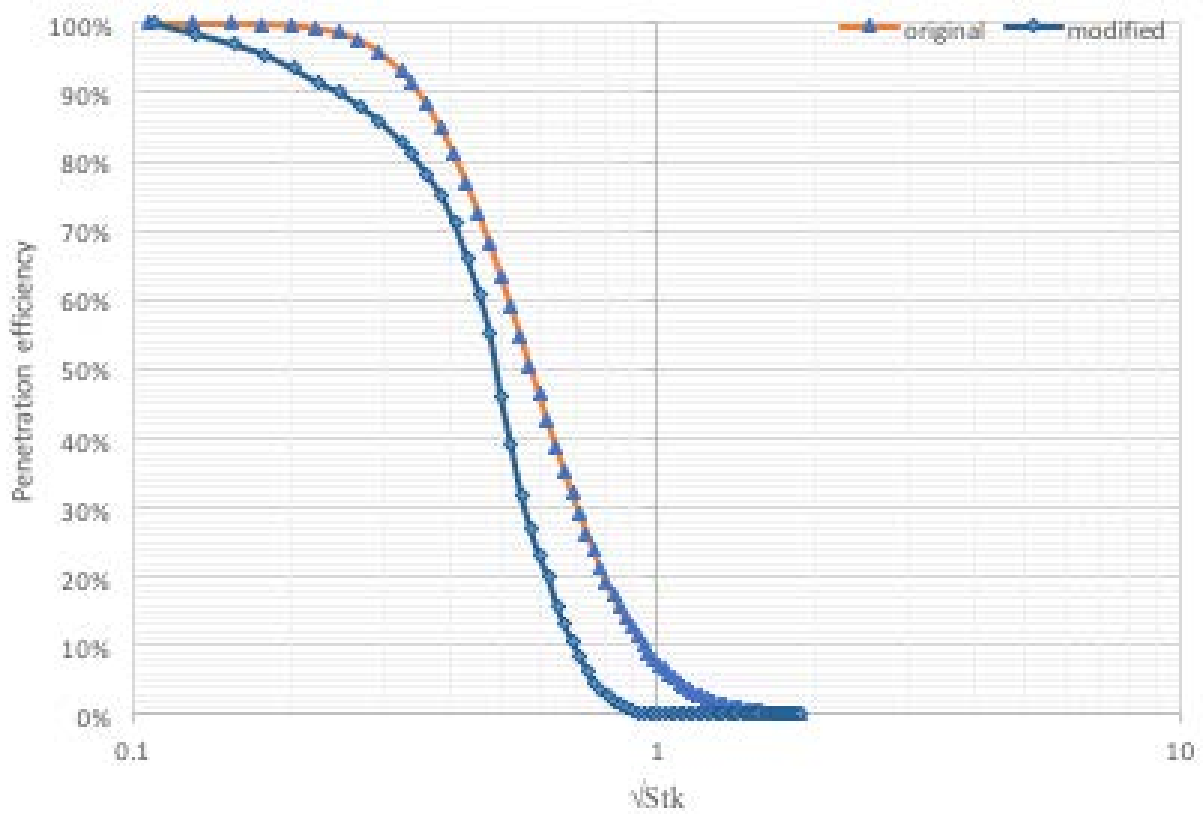
1. Determine the effect of design parameters on performance of the PM 2.5 impactor



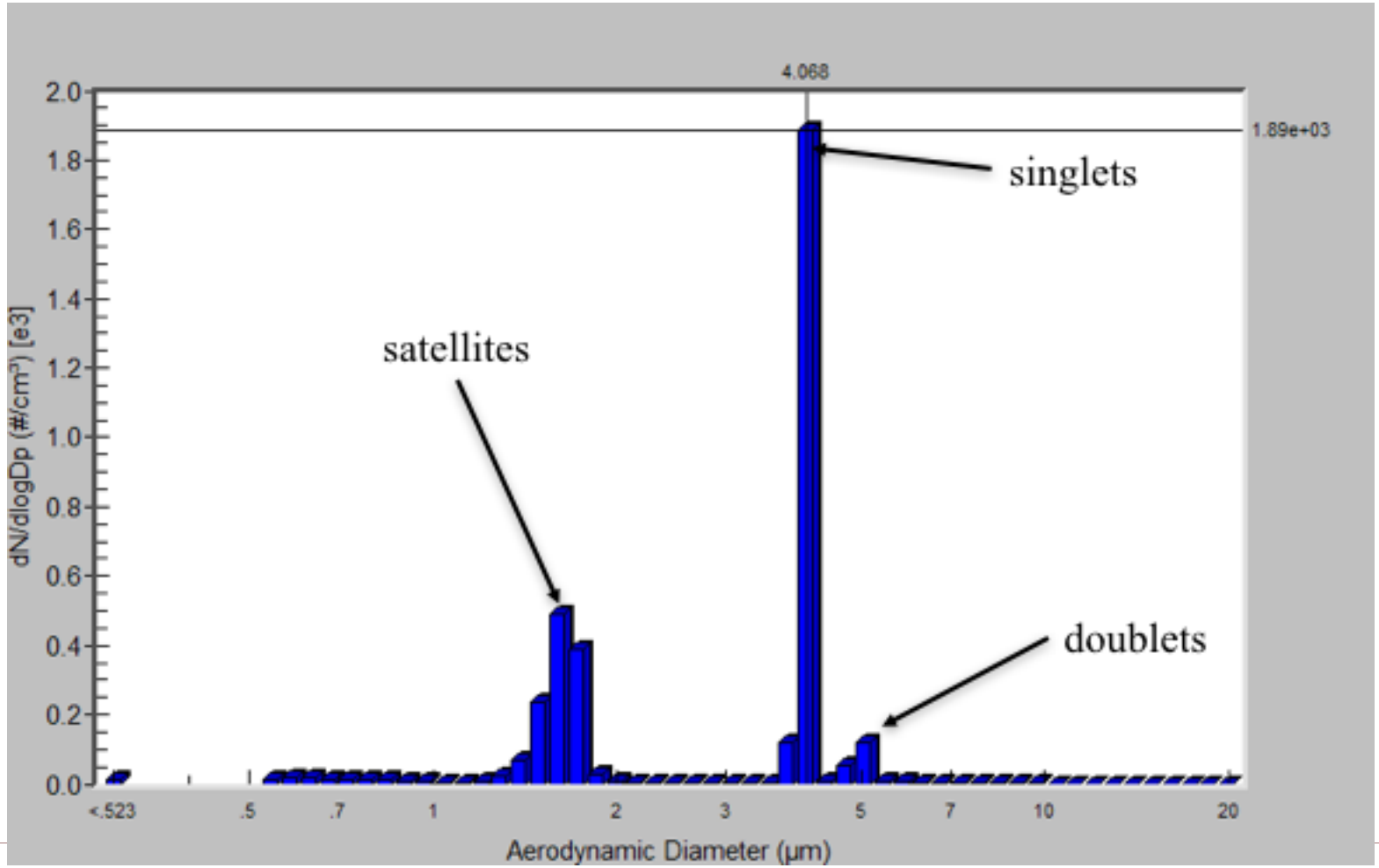
Original Modified

<u>Design Parameters</u>

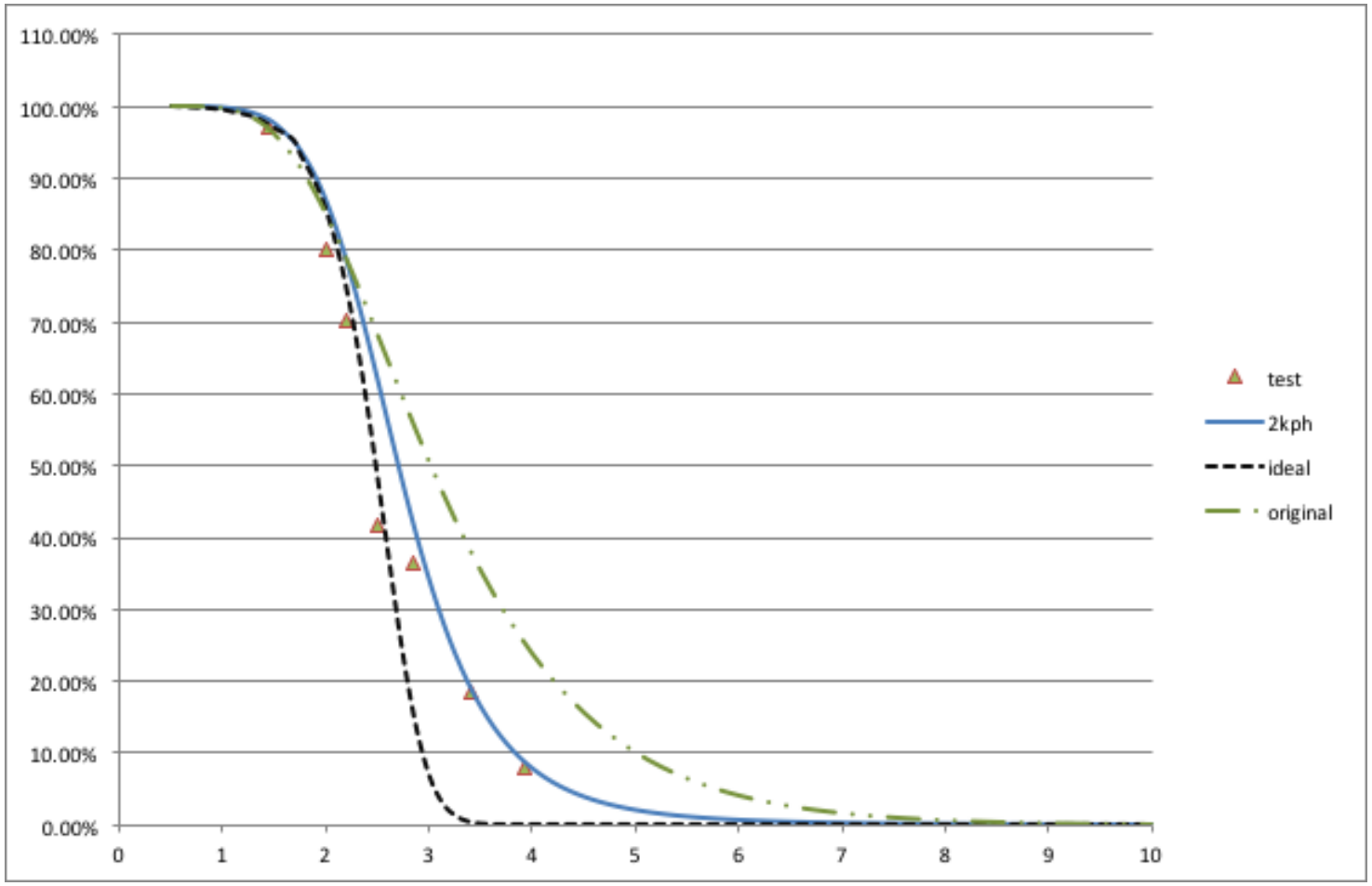
1. Throat Diameter
2. Rate of Convergence
3. Throat Length
4. Chamfering
5. Ring



2. Correct for doublets, triplets and satellites

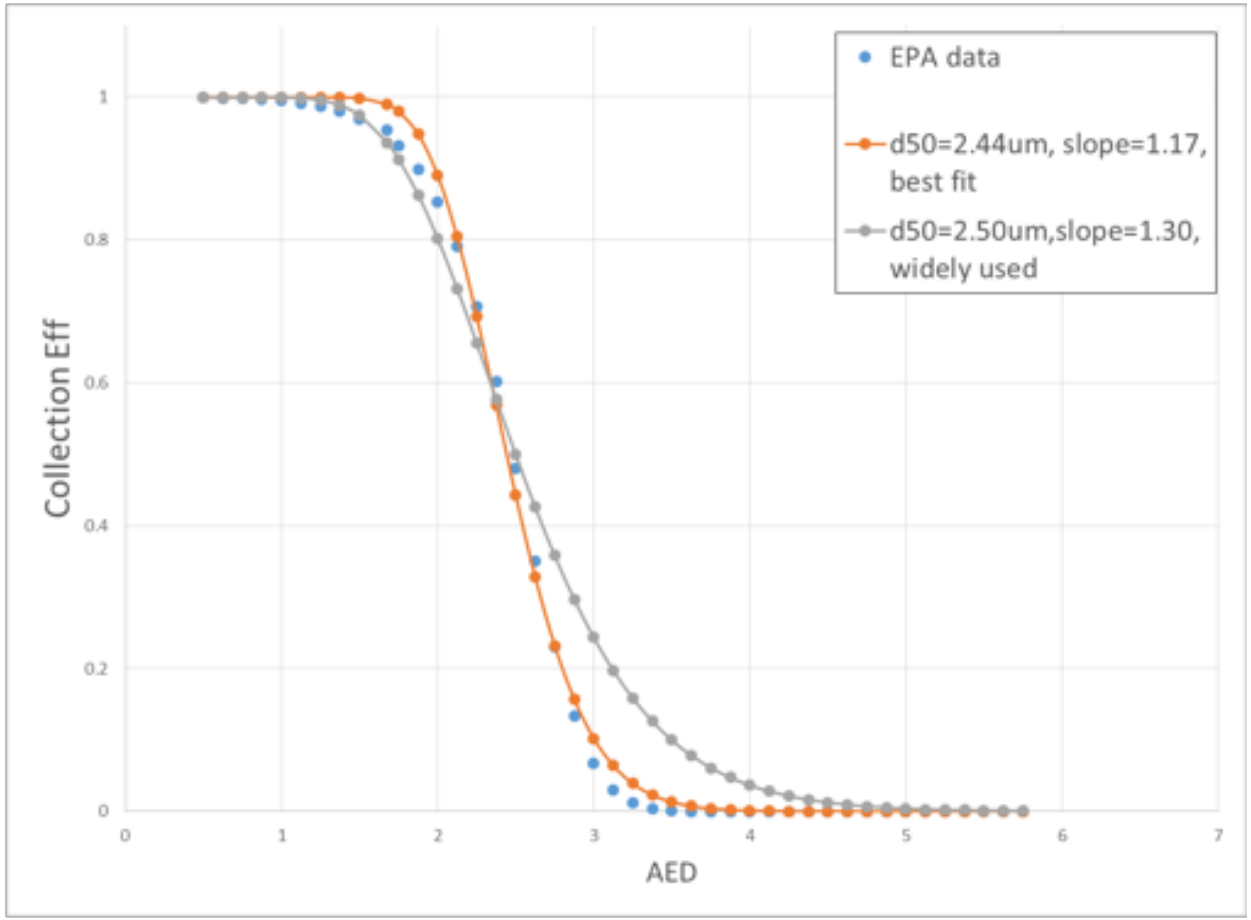


Evaluate multiplet correction based on Aerodynamic Particle Sizer (APS)

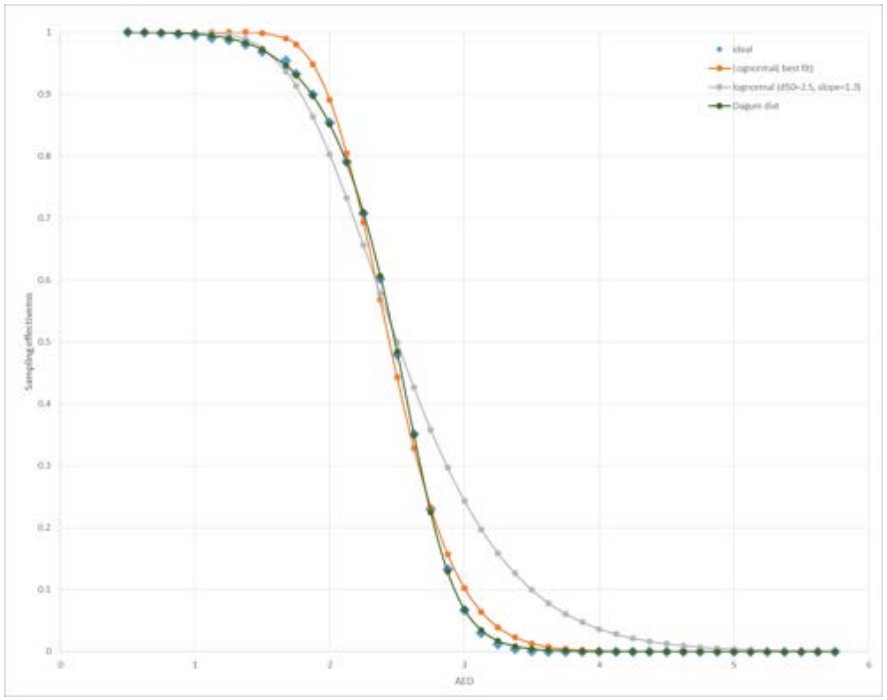


3. Determine the best fitting continuous distributions to sampler data

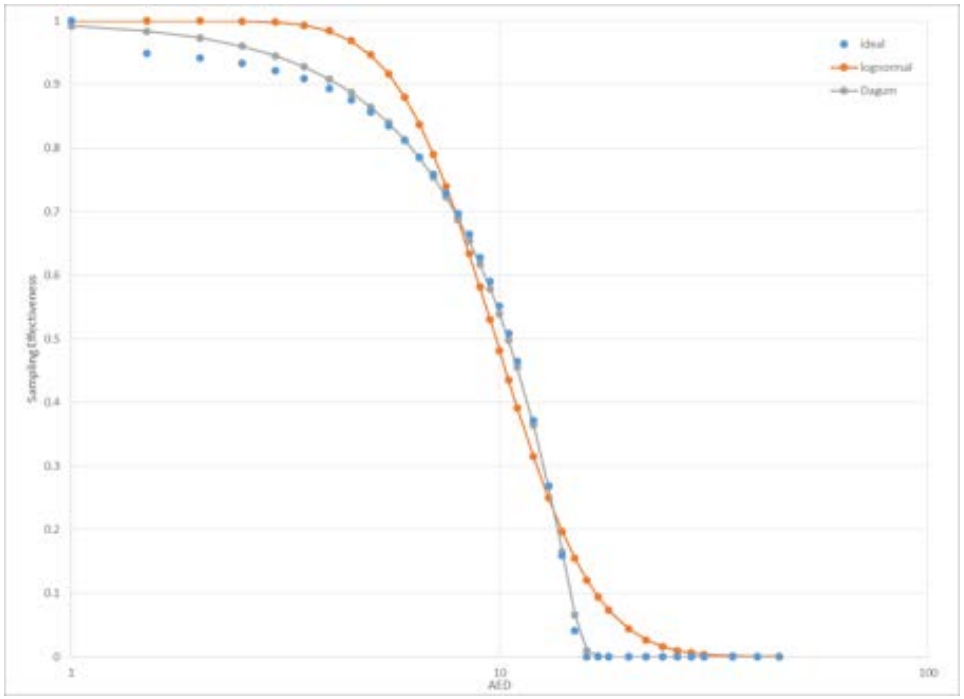
AED(um)	EFF
0.5	1
0.625	0.999
0.75	0.998
0.875	0.997
1	0.995
1.125	0.991
1.25	0.987
1.375	0.98
1.5	0.969
1.675	0.954
1.75	0.932
1.875	0.899
2	0.854
2.125	0.791
2.25	0.707
2.375	0.602
2.5	0.48
2.625	0.351
2.75	0.23
2.875	0.133
3	0.067
3.125	0.03
3.25	0.012
3.375	0.004
3.5	0.001



Best fit continuous distribution for the FRM samplers



PM 2.5



PM 10

Dagum vs Lognormal Distributions for FRM Samplers

Conclusions and Next Steps

Ronald E. Lacey

Professor, Biological and Agricultural Engineering

Director, CAAQES

TEXAS A&M AGRILIFE RESEARCH

Conclusions from Dr. Faulkner's Particulate Matter Sampling Research

- Large particles do penetrate the PM10 sampler creating an error of 3 – 5% at 8 kph
- The difference between the thoracic curve and the PM10 sampler penetration would suggest that large particle penetration does not contribute to health concerns but may affect research and regulatory activities.
- The Low Volume TSP sampler does not perform as previously assumed.
- PM2.5 sampler design parameters should be further evaluated.

Next Steps for CAAQES TAMU

- Determine the net effect of sampler performance on agricultural operations for PM10 and PM2.5
  - Development of emission factors
  - Enforcement of NAAQS
- Fill positions to replace Drs. Parnell and Faulkner. At least one will have a significant air quality component.
  - Cotton Chair - Professor
  - Process engineer – Assistant Professor

Questions?